Insert to May/June 2022 Sponsored by Nova Eye Medical

GT Glaucoma Today

TARGETING AND TREATING ALL GLAUCOMA ANATOMY WITH CANALOPLASTY

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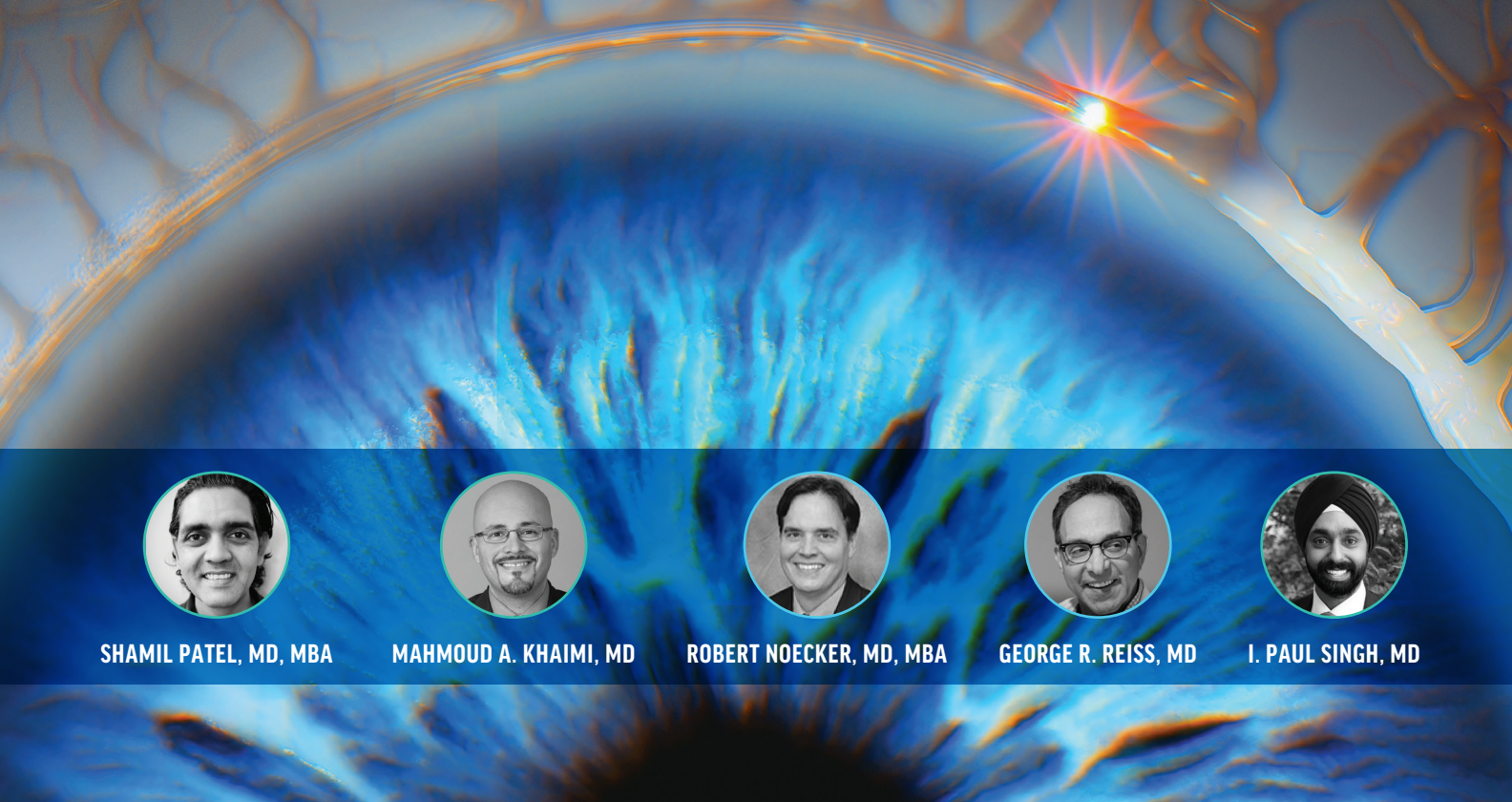

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CANALOPLASTY: THE IMPLICATIONS OF RESTORING PHYSIOLOGIC FUNCTION

Canaloplasty addresses resistance in the trabecular meshwork, the Schlemm canal, and collector channels. Addressing the entire system has benefits beyond the obvious.

WITH SHAMIL PATEL, MD, MBA; MAHMOUD A. KHAIMI, MD; ROBERT NOECKER, MD, MBA; GEORGE R. REISS, MD; AND I. PAUL SINGH, MD

The advent of MIGS has rightly been heralded for a much-improved safety profile relative to incisional glaucoma surgeries. When we start to look at the various options within the MIGS category, though, it becomes apparent that some of the MIGS options are not just safer, but also more comprehensive in terms of the targeted tissue.

Canaloplasty is experiencing somewhat of a renaissance in the procedural management of glaucoma. While stents and stripping MIGS procedures are typically directed at one point within the conventional outflow pathway, canaloplasty gives us the potential to have an effect on the entire conventional outflow pathway. Fundamentally, as our understanding of the pathophysiology of glaucoma has improved, so has our understanding of the drainage system beyond the trabecular meshwork (TM) and the opportunity to target the canal and the collector channels, in addition to the TM, in the treatment of glaucoma patients. Furthermore, this procedure restores and preserves the physiologic properties of dynamic TM tissue and the distal outflow system.

The canaloplasty procedure (iTrack and *iTrack Advance, Nova Eye Medical), safely restores and impacts all levels of the natural drainage system, including the TM tissue, Schlemm canal (SC), and the distal collector system. Canaloplasty begins this restoration at the level of the TM, physically stretching the tissue by intracanalicular expansion, expanding the extracellular matrix space, and thereby restoring homeostatic functions.[1] Canaloplasty also clears debris around the TM and in the SC, thus restoring patency. Micropore density on the inner wall of the SC has been shown to be decreased in glaucomatous eyes, and there is a lack of compensatory increase in micropore size and density, which induces IOP elevation.[2] Resistance within the SC also affects the rate and volume of aqueous flow from the TM, paracellular and transcellular flow gradients, and the tight endothelial cell junctions.[3] As a third mechanistic effect, iTrack also flushes collector channels, which serve as the linkage to the distal drainage system. Up to 90% of collector channels are blocked with herniated TM tissue in eyes with primary open-angle glaucoma (POAG).[4,5] Canaloplasty pushes herniations out of the collector channels and dilates the collector channels to improve outflow facility to the circumferential drainage pathway.[6,7]

I recently sat down with a panel of glaucoma experts to discuss the effect of canaloplasty performed with the iTrack device on the target tissue within the aqueous drainage pathway and the implications of this intervention for patients in real-world practice (Figure 1).

—Shamil Patel, MD, MBA

Figure 1. From left to right, Drs. Reiss, Khaimi, Patel, Noecker, and Singh discuss iTrack at a roundtable at ASCRS 2021 in Las Vegas.

*iTrack Advance is not available for use or sale in the USA.

SIDEBAR

Glaucoma is associated with a pathophysiology of the entire conventional outflow pathway.

TRABECULAR MESHWORK

Up to 75% of outflow resistance is localized within the trabecular meshwork (TM).[1] The juxtacanalicular portion of the TM, which lies immediately adjacent to Schlemm canal (SC), is thought to account for the majority of reduced outflow facility within the TM of primary open-angle glaucoma (POAG) eyes.[1,2]

SCHLEMM CANAL

The dimensions of the lumen of SC are smaller in POAG eyes[3] and can account for up to 50% of decreased outflow facility in POAG eyes.[4]

COLLECTOR CHANNELS

Up to 90% of collector channels may be blocked by herniations of the TM in POAG eyes.[5,6] These herniations into the collector channels result in increased outflow resistance.[5,6]

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Shamil Patel, MD, MBA: How does the iTrack procedure affect the anatomic structures in the conventional outflow pathway, and why might that be meaningful in the treatment of POAG?

I. Paul Singh, MD: One of the challenges of treating glaucoma is that we do not know where the resistance to outflow is occurring. Absent that information, strategies that target multiple points of the pathway are highly rational. In studies we have performed in our clinic using intraoperative OCT, we have shown that iTrack stretches open the SC, enlarges the distal collector channels, and stretches open the TM (unpublished data; scan the *QR code* on page 4 to watch a related video; see *Figure* 2). What is particularly interesting is that we noticed those effects after the microcatheter was withdrawn from the eye, suggesting that the viscodilation portion of the procedure was producing a potentially durable anatomic effect. It is difficult to discount the role of microcatheterization in breaking adhesions, but certainly viscodilation has beneficial effects on the most likely areas of resistance within the conventional pathway.

George R. Reiss, MD: When you perform a procedure that addresses multiple points of resistance, you're increasing the likelihood of addressing the problem at all of its root causes.

Mahmoud A. Khaimi, MD: The outflow pathway is complex, and all the structures have to work together for the entire system to function.[8] Proper aqueous drainage is dependent on each of the TM, SC, and distal collector channel systems functioning as intended. And so, if you have a procedure that can treat all of these parts of the outflow system all at once and not just focus on one area, then I think you've maximized your chances for good IOP lowering (See *Sidebar*).

Dr. Singh: The outflow pathway is complex, but outflow is also pulsatile and segmental.[9] Conceptually, stenting is effective to bypass likely areas of resistance, but it is a focal treatment. Whereas, iTrack is performed over the entire 360° of the outflow pathway, so we are cleaning, clearing, and restoring the whole system.

Robert Noecker, MD, MBA: To build on that concept of targeting likely areas of resistance, it's important to point out that the iTrack procedure can be added to other MIGS.* Because the TM is spared, you can still do a goniotomy, either at the

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> "That's why canaloplasty makes so much sense: We're treating the problem tissue in the eye, and more to the point, because of the high degree of safety, we are doing so earlier in the disease continuum."
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> – Robert Noecker, MD, MBA

time of the procedure, or in the future. You can still put a stent in later to get additional IOP lowering. iTrack preserves future options. When you are deciding on a glaucoma intervention, you think about two steps down the road.

ADDRESSING THE ROOT CAUSES OF GLAUCOMA

Dr. Patel: Canaloplasty with iTrack restores physiologic outflow, which, in turn, preserves important homeostatic mechanisms for addressing IOP fluctuations.[10-14] Why is that important?

Dr. Noecker: The problem tissue in glaucoma is the TM and SC. In other parts of medicine, you usually treat the diseased part of the organ, but historically we have not done that in glaucoma. We either suppress aqueous flow or, before MIGS, performed bypass procedures with trabeculectomy. That's why canaloplasty makes so much sense: We're treating the problem tissue in the eye, and more to the point, because of the high degree of safety, we are doing so earlier in the disease continuum. That potential to treat early stops progression and prevents vision loss, while also keeping future options viable.

Dr. Reiss: One of the real frustrations I have had over the past 25 years that I have been in practice is that we did not have a viable way to intervene early with surgery because of the concern over side effects and complications. I really cannot stress enough how meaningful it is for patients to have an option like iTrack, associated with its favorable safety profile. Now, it's not only feasible to introduce surgical options early in the natural history, but also highly rational.

PROCEDURAL CONSIDERATIONS

Dr. Patel: The iTrack delivers more than 100 µL of viscoelastic over 360° of the canal, and it is the only such device to deliver viscoelastic via a pressurized mechanism. Throughout the procedure, the surgeon maintains control of the delivery. Is there any benefit in having control over how much viscoelastic is delivered during a canaloplasty procedure?

Dr. Noecker: It allows you to titrate the delivery based on the patency of the SC. However, personally, I do not titrate when I am viscodilating because I do not worry about hypotony like I would with a bypass procedure like trabeculectomy. I can be fairly aggressive, and I do as much as I can in one setting.

Dr. Khaimi: There are cases where titrating is valuable, for example in an eye where I feel resistance while advancing the microcatheter through the canal.

Dr. Singh: I agree, and there is another underappreciated aspect of the iTrack that becomes relevant here: The illuminated fiberoptic tip. First of all, that lets you know where you are in the eye, so it gives confidence to the surgeon. Second, as you gain experience with the device, you can use it to gauge how easy it is to advance the microcatheter through the canal. And third, as you retract the microcatheter, you can direct viscoelastic accurately to each quadrant because, again, you know exactly where the device is inside the canal. Having that control is important.

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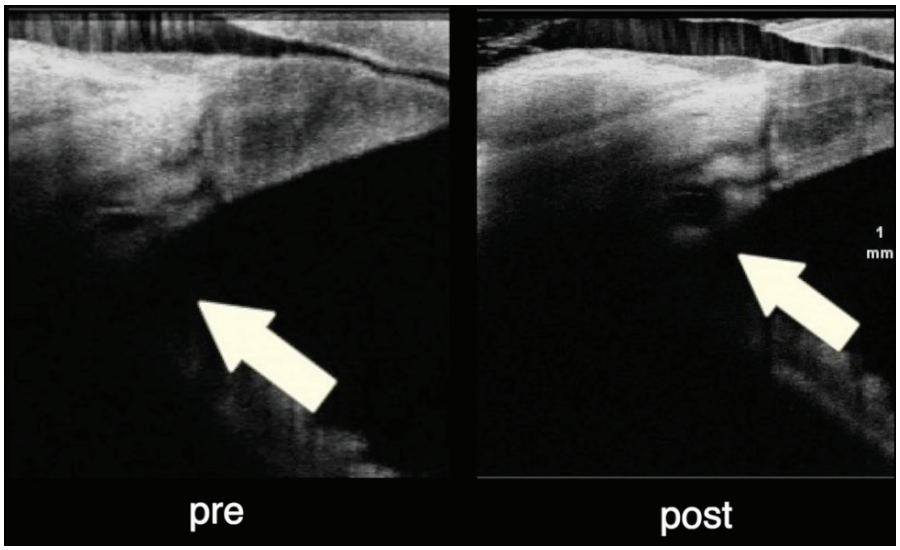

Figure 2. Side-by-side comparison of pre- and post-viscodilation demonstrating three distinct mechanistic effects. (1) Expansion of the SC can be easily appreciated (white arrow). (2) In the post image, there is also evidence of the impact of canaloplasty on the collector channels (black, wavy lines extending from the SC border), with the opening to the channel more evident and the channel as a whole appearing to be dilated, suggesting that fluid is now draining through these structures. (3) In this view, thinning of the TM tissue is also evident.

Dr. Reiss: How many clicks is everyone using?

Dr. Singh: I average around three clicks per clock hour, so around 40 for the full 360°.

Dr. Noecker: I target 40-plus for the whole 360°.

Dr. Khaimi: I would say anywhere from 45 to 60 depending on how the microcatheter advances through the canal.

Dr. Patel: I have been averaging about 85, but that is because I recently changed my technique to viscodilate both while advancing and retracting the microcatheter. I am not sure if it makes a difference to do this, but it is something I am trying.

Dr. Noecker: Mechanistically you have to think there's a ceiling where the viscoelastic just exits the system without having any additional benefit for opening the canal and other structures in the pathway.

Dr. Singh: In addition to giving the surgeon control over where viscoelastic is introduced, iTrack delivers OVD in a pressurized manner. There is benefit to that. Compared to other devices for the canaloplasty procedure, which simply deposit the viscoelastic, the pressurized mechanism with iTrack helps stretch open the canal and flush the canal and adjacent structures.

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Dr. Noecker: We have been talking about the effect on the canal and collector channels, and that seems obvious, but you can't discount the effect on the TM, as well. If you are getting pressurized flow of viscoelastic to stretch the canal, you are probably also getting backflow through the TM to some extent. You can actually see this effect in some eyes, for example pigment coming back to the anterior chamber in darkly pigmented eyes.

Dr. Reiss: I think the volume of ophthalmic viscosurgical devices introduced during viscodilation is a crucial point. The key is to use enough volume of viscoelastic to get into the collector channels to flush them out so you can fully reset the entire drainage pathway.

> "Compared to other devices for the canaloplasty procedure, which simply deposit the viscoelastic, the pressurized mechanism with iTrack helps stretch open the canal and flush the canal and adjacent structures."
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> – I. Paul Singh, MD

DESIGNED FOR PERFORMANCE

Dr. Patel: How often do you find you cannot advance the microcatheter for the full 360°?

Dr. Singh: I find it to be very rare. I can't remember the last time that I didn't go all the way around.

Dr. Khaimi: The iTrack microcatheter is designed with a guidewire inside that adds stiffness to help guide the device through the canal. It is not so stiff that it forms a new pathway, but it definitely helps maneuver through the canal for the full 360°. We looked at data from our center and found that happened in fewer than 5% of cases (unpublished data). But if that happens, you can always go the opposite direction, too. If you are advancing the microcatheter and run into an obstruction, you can always reverse and try going the other way.

Dr. Singh: You can certainly go in the opposite direction, but surgeons also shouldn't stress if they can only advance the microcatheter for, say, 270°. There is likely going to be significant efficacy associated with that, even if you don't get all the way around the canal.

Dr. Khaimi: If you can treat for at least 180°, you're going to get results. The patient may be on more drops, but the pressure will more than likely come down.

THE PATIENT PERSPECTIVE

Dr. Patel: We have been talking about the anatomic effects of iTrack and the implications for controlling pressure. The intervention might also reduce medication burden postoperatively. What does that really mean for our patients?

Dr. Reiss: The definition of maximum tolerated medical therapy is nebulous. For some patients, we can use the conventional thinking that anything more than three medications is maximal. There is almost a direct negative correlation between number of drops and adherence. But for some patients, the answer to 'what is maximum tolerated therapy?' is actually one due to intolerance or adverse effects.

Dr. Singh: We need to reframe that question, actually. The definition of maximum tolerated medical therapy is not necessarily based on the number of medications or number of bottles; more importantly, 'what can the patient tolerate, and what's the likelihood of them staying on that regimen long-term?' Compliance is a big part of my definition of uncontrolled glaucoma, and that's why intervening early in those patients makes sense. ■

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